Concert Hall Acoustics: Paper ICA2016-511

Acoustics of new and renovated chamber music halls in Russia

Alexander Fadeev, Nikolay Kanev, Anatoly Livshits, Andrey Nechaev, Anton Peretokin, Eugeny Pimenov, Vitaly Rodenkov, Natalia Shirgina

Acoustic Group, Russia, nikolay.kanev@acoustic.ru

Abstract

In recent years several classic halls for chamber music were renovated and a few halls of similar capacity were built in Russia. We have selected the most interesting ones and measured their acoustical parameters. Here we are presenting detailed descriptions of five halls in Moscow, Tula, Ufa and Penza in combination with the measurement data. Some of them have long reverberation time and their acoustics is considered as very good. In two halls there is an organ, else one is going to be supplied with new organ. Moreover, the hall in Ufa is destined not only for chamber music; amplified performances may take place there. In spite of big difference between these halls we try to find connecting features and compare them with well-known chamber music halls. One of the main results is that we revealed the trend that general audience has subjective preferences towards longer reverberation time. Those results were obtained at the same time as evaluation of acoustics changes in Bolshoi Theatre Historic stage and Great Hall of Moscow Conservatory due to reconstruction. Else one interesting result of reverberation time measurement in occupied and unoccupied hall is presented in the paper.

Keywords: room acoustics, chamber music halls, acoustic parameters
Acoustics of new and renovated chamber music halls in Russia

1 Introduction

Over the last years many small concert halls have been renovated or built in Russia. In this paper we consider the hall as small if it has no more than 500 seats. Some of them are intended only for chamber music, some are multipurpose but they are regularly used for chamber music concert as well. Acoustics of new or renovated symphony halls and opera houses is usually well described [1,2], whereas there are limited data about small music halls. Detailed analysis of chamber-music halls in Europe and Japan with acoustical data for them was given by Hidaka and Nishihara [3]. In order to evaluate chamber-music halls in Russia several halls were chosen and the room acoustical parameters were measured.

2 Halls description

Five halls in different Russian cities were examined. They have the unique history and architecture, here we describe briefly each of them. Schemes and pictures of considered halls are given in Figures 1-5.

Two halls belong to the Tchaikovsky Moscow State Conservatory founded in 1866 by Nikolay Rubinstein. There are three concert halls in the Moscow Conservatory, the most famous is the Great Hall. Its acoustic parameters were measured several times and some results were published [4], so acoustics of the Great Hall seems to be well known. But acoustics of other halls is not studied so carefully.

First of them is Maliy (Small) Hall with 436 seats which was opened in 1898. There is an organ produced by Alexander Schuke Orgelbau and installed in 1959. In the opinion of music lovers the hall has ideal acoustics. It is famous for chamber music. Different competitions including the International Tchaikovsky Competition and festivals take place here. In 2015 the Maliy Hall was renovated. Changes of its acoustics are described below.

The oldest concert hall of the Moscow Conservatory is Rachmaninov Hall. It was built in 1890 for Moscow Synodal School. In 1968 the hall was affiliated to the Moscow Conservatory and reopened in 1983 after long renovation. There is a balcony without seats along all walls, all seats are in the main floor. The hall is a stunning building due to its beautiful multiple windows and elegant decoration of the ceiling and walls. A lot of chamber music and choir concerts are held almost every day, classical and modern music are also performed here occasionally here. In 2016 renovation of the hall was finished. Nevertheless its acoustic parameters before the renovation have been measured and are presented below.

Another hall with a long history is the Column Hall of the Tula Philharmonic, which was built in 1856 as a part of the House for Assembly of Nobles. The hall has rectangular shape with a balcony along all walls. There are many windows on side walls, so the day light comes inside. The distinguishing feature of the hall is a set of columns along the balcony, which defined his
name. The seats are usually installed between the columns as shown in Figure 3 in a number of about 300. It is possible to increase capacity by means of additional chairs behind the columns and on the balcony, but these seats have the poor visibility of the stage. Maximal capacity of the hall is about 500 seats.

In 2013 the construction work of a new house for the Penza Philharmonic was finished. The building has two halls, one of them is designed for chamber music and equipped with an organ by Hugo Mayer. The hall is close to rectangular shape, but one wall is curved. Moreover, this wall is totally made of glass. The organ occupies the entire area of the front wall, there are two narrow balconies on the rear wall.

The Malyi Hall of the music house “Bashkortostan” in Ufa can be considered as a good example of multifunctional hall. The hall was designed in contemporary style and reconstructed in 2014. The side and back walls have irregular surfaces and contain some perforated panels for sound absorption. Now it is intended for chamber music, piano concert, at the same time the PA system is installed in the hall. So its acoustics is adjusted for different musical performances.

Figure 1: Maly Hall of the Moscow Conservatory
Figure 2: Rachmaninov Hall of the Moscow Conservatory

Figure 3: Column Hall of the Tula Philharmonic
Figure 4: Organ Hall of the Penza Philharmonic

Figure 5: Malyi Hall “Bashkortostan”
3 Acoustic parameters

Table 1 contains volume, capacity and measured acoustic parameters of five small halls. In Table 1 we also introduced double letter abbreviations for the concert halls. All halls are rectangular or very close to rectangular in plan. The only exception is PP, which has curved side wall. The hall length ranges from 21.6 to 31.0 m. The ratio of length to width is 1.8-2.2 for different halls, height of all halls is 7.2-12.4 m. The ratio of width to height is very different; in MC and PP it is close to 1, whereas in TP it is 1.8. The seating capacities range from 172 to 436 and the volumes range from 1920 to 4600 m³. Four halls have large ratio V/N, which ranges from 11 to 16 m³, the smallest value is 6 m³ in MC.

Acoustics parameters were measured in the halls without audience and with no instruments on the stage in accordance with ISO-3382. Measured parameters are given in Table 1, where the subscript "mid" means that the octave band average is for 500 and 1000 Hz. Figure 6 illustrates the frequency characteristics of the reverberation time in unoccupied halls. Four traditional (MC, RC, TP, PP, MB) halls have long reverberation, while in the modern multipurpose hall (MB) it is respectively short.

Table 1: Acoustic parameters measured in unoccupied halls

<table>
<thead>
<tr>
<th>Hall</th>
<th>V</th>
<th>N</th>
<th>T_mid</th>
<th>EDT_mid</th>
<th>BR</th>
<th>C60</th>
<th>STI</th>
<th>G_mid</th>
<th>ITDG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maliy Hall of the Moscow Conservatory (MC)</td>
<td>2800</td>
<td>436</td>
<td>2.53</td>
<td>2.56</td>
<td>0.93</td>
<td>-3.4</td>
<td>0.39</td>
<td>13.9</td>
<td>19</td>
</tr>
<tr>
<td>Rachmaninov Hall of the Moscow Conservatory (RC)</td>
<td>2490</td>
<td>252</td>
<td>2.08</td>
<td>2.06</td>
<td>1.05</td>
<td>-1.5</td>
<td>0.47</td>
<td>13.3</td>
<td>15</td>
</tr>
<tr>
<td>Column Hall of Tula Philharmonic (TP)</td>
<td>4600</td>
<td>300</td>
<td>2.26</td>
<td>2.24</td>
<td>1.18</td>
<td>-2.0</td>
<td>0.43</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Organ Hall of Penza Philharmonic (PP)</td>
<td>3200</td>
<td>200</td>
<td>1.72</td>
<td>1.80</td>
<td>1.23</td>
<td>-1.0</td>
<td>0.46</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Maliy Hall “Bashkortostan”(MB)</td>
<td>1920</td>
<td>172</td>
<td>0.99</td>
<td>0.87</td>
<td>0.94</td>
<td>4.3</td>
<td>0.60</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

In one hall (MC) the reverberation time was measured with the audience, but with no musicians and instruments on the stage. This measurement is compared with the same in empty hall in Figure 6. Calculation of the reverberation time in the occupied hall by means of empirical method proposed by Hidaka [5] is given in Figure 6 as well. We can see than measured and calculated values are very close. This verification allows to calculate the occupied RT values from measured unoccupied values for other halls.

Frequency dependence of the reverberation time can be characterized by RT normalized to the values at 500 Hz. In Figure 7 normalized RTs are presented for traditional halls. We can see the similar dependence for all halls. There are variations between values 1.02 and 1.27 below 500 Hz, at high frequencies only RC differs from other halls. It is interesting to compare reverberation time of the Russian traditional halls with the European and Japanese halls. Figure 7 contains the median values of normalized reverberation time in occupied halls in Europe and.
Japan from [3] and the median values of four Russian halls. According to the results the reverberation time of chamber-music halls in Europe and Russia is very similar.

Figure 6: Measured reverberation times in five unoccupied halls (left) and verification of the method for calculation the RT in occupied halls [5] by the example of MC (right)

Figure 7: The reverberation times under occupied conditions with audience in four traditional halls normalized to the value at 500 Hz (left) and median values in comparison with European and Japan Halls [3] (right)
Another interesting comparison may be made for the strength factor $G_L$ (unoccupied) and the bass ratio (occupied). Figure 8 is taken from [3] and contains two points corresponding to the halls MC and RC in which the strength factor was measured. We see that the Russian halls are in area typical for the European halls as well.

Acoustic parameters of the multipurpose hall (MB) differ from parameters obtained in traditional halls. But MB is comparable with modern hall described in [3].

![Figure 8: The sound strength $G_L$ (unoccupied) vs. the bass ratio BR (occupied) and $G_L$ and BR values for MC and RC](image)

Source: (Hidaka, 2004)

### 4 Subjective evaluation

Figure 9 contains $T_{mid}$ for occupied halls vs. their volumes and optimum reverberation time at middle frequencies for chamber-music halls (red line) according to Russian regulations [6]. All traditional halls have longer reverberation in comparison with recommendations. As the same time some musicians stated that the halls with 500-600 seating are optimum if the reverberation time is 1.5 to 1.7 s [3]. Only MC and TP (with maximal capacities) have such capacity and their reverberation is slightly longer as well. In music lovers opinion four traditional halls have very good or excellent acoustics.

At present we have no enough data to give complete evaluation of subjective acoustical qualities of the considered halls. There are several educated opinion collected from the professional musicians and music lovers below.
In all the halls musicians feel comfortable on the stage, even in MB in spite of short reverberation. It seems the small stage of MB and hard walls provide enough acoustic support for musicians. For organ music the reverberation time of MC is appropriate, while in PP it is too short. TP is good for organ music, there is a plan to equip it with the new organ.

Listeners find that traditional halls have good or excellent acoustics. Some listeners consider MC and RC are too loud especially for piano concerts.

![Figure 9: The reverberation times of the occupied halls and optimal RT (red line) according to Russian regulations. The change of RT in MC because of reconstruction is indicated by arrow](image)

It would be interesting to analyze subjective evaluation of MC before and after renovation which was finished in 2015. The reverberation time change due to renovation is shown in Figure 9 by an arrow. The hall became more reverberant and most music lovers found that the acoustic changes were positive. Many musicians say that hall’s acoustics was preserved, soloists agree with musicians but they note that the hall became more difficult for singing. Similar evaluations were given after reconstruction of the Great Hall of the Moscow Conservatory in 2011 [4], in which the reverberation time increased from 1.8 to 2.0 s. The reconstruction of the Bolshoi Theatre resulted in increase of the reverberation time of the Historic stage by 0.2-0.3 s. It was evaluated as undoubted improvement of acoustic properties of the Historic stage due to the reconstruction.

We can conclude that the audience prefers more reverberant halls for classic and chamber music. Moreover, most acoustic changes in the halls are considered as positive if they result in increasing of reverberation. This observation coincides with the trend revealed by Kravchun for organ halls [7]. During last century the optimum reverberation time was rising from 2.5 to 3.5 s for the hall with volume of 20000 m³.
5 Conclusions

Five concert halls with capacity under 500 seats located in Russia were studied. Four of them have acoustics typical for European chamber-music halls. RC, MC and TP have the reverberation time 2.1-2.5 s at middle frequencies, which are significantly higher than ones recommended by Russian regulations (1.5 s) and found in [3] (1.5-1.7 s). In spite of long reverberation these halls are evaluated as good or excellent by musicians and audience. One of the possible reasons is that subjective preferences have tendency to more reverberant halls.

Many new or renovated halls are constructed for different type of musical performances including those which require sound amplification. MB is an example of new multipurpose hall. Its reverberation time is much smaller than in traditional halls, but conditions on the stage make it comfortable for musicians and soloists. It demonstrates opportunity to combine different functions in one hall, but it is impossible to replace traditional concert halls by multipurpose halls.

References